

# Backscattering of photons into the Vertex Detector from Beam Losses Along the Extraction Lines

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## Contents

- Introduction
- Backscattered photons from disrupted beam losses
- Mokka simulation & Marlin Reco
- Conclusion & prospects



# Introduction

- In spite of all the attention put in the design, the extraction will be the place of secondary particles generation

## Several origins:

- Disrupted beam particles
- Synchrotron radiation  
(beamstrahlung,  $e^+e^-$  pairs, radiative Bhabhas)

## Several locations:

- BeamCal mask
- Beam pipe
- Collimator ...
- Beam dump

- We would like to have (recalled during IRENG07):
  - List of background (upstream, mask and downstream sources\*)
  - Impact for all the (sub-)detectors concept, i.e need to run the detector simulation for such events

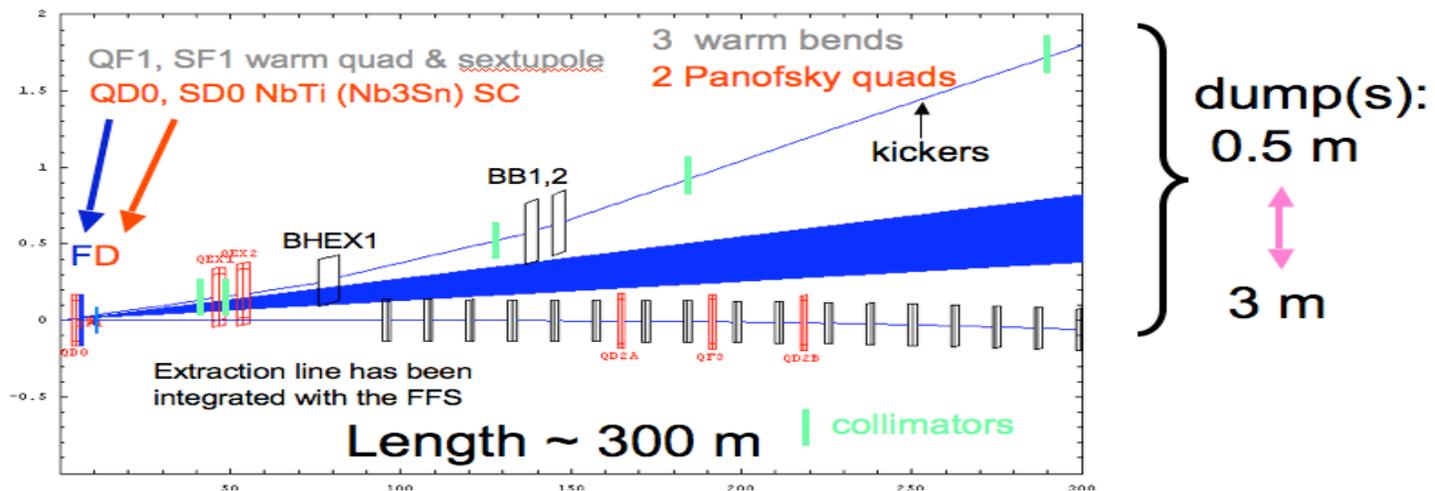
\*14mrad is the baseline but we need an evaluation for other extractions lines

... **ilc** Aim :  $V_{\text{vertex}} D_{\text{detector}}$  hits from backscattered photons

- How many **backscattered photons**, from beam losses along the extraction line, can reach the **IP** via direct lines of sight passing through the BeamCal aperture (which is the smallest aperture) and still create background in the **VD\***?
- Illustration using the disrupted beam losses in the 2mrad extraction line: **but arguments and methods are general**

## New “minimal” extraction line concept

→ Explicit goals : short & economical, as few and feasible magnets as possible, more tolerant and flexible

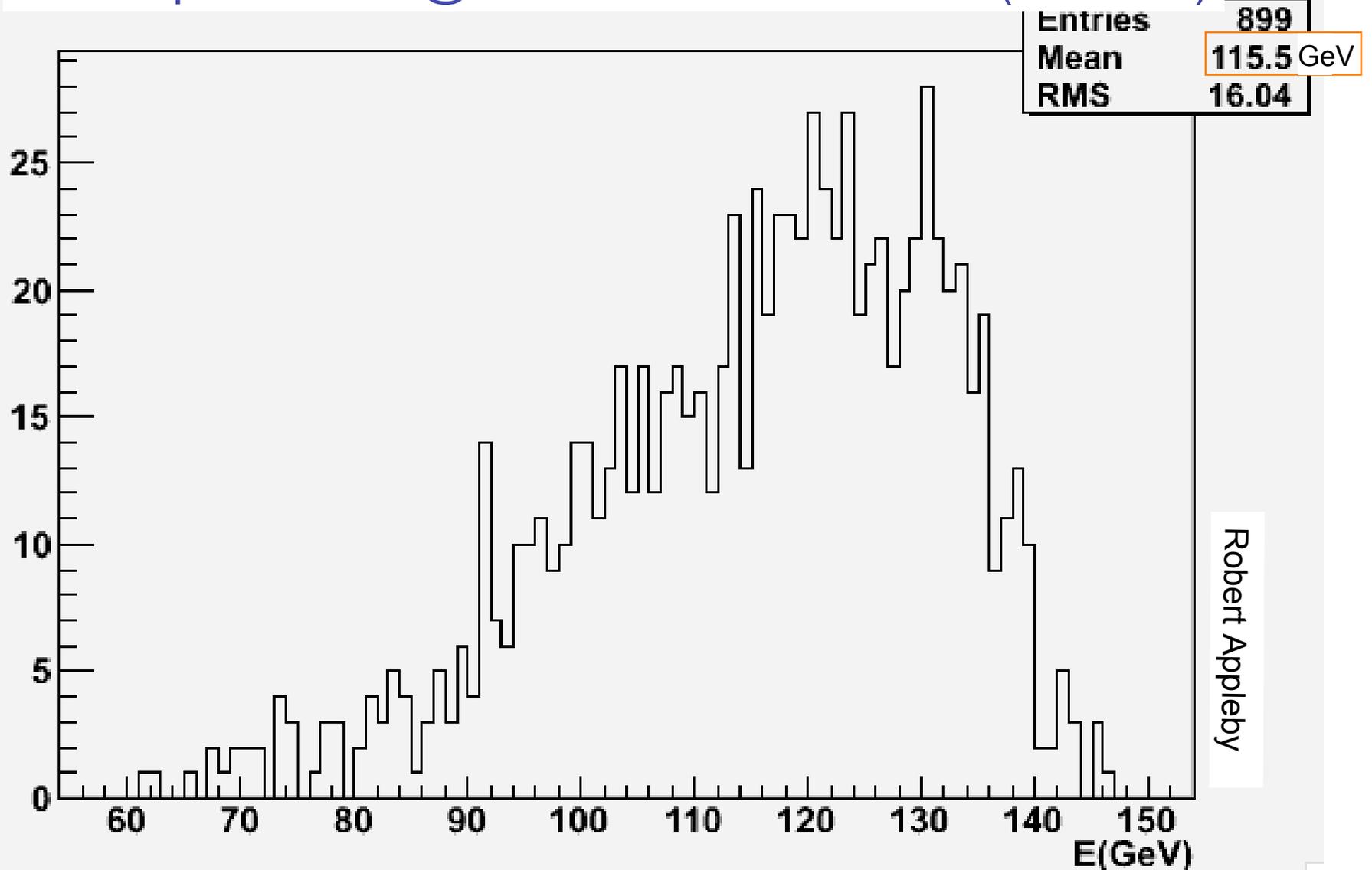


Improved 2-mrad crossing angle layout for the International Linear Collider, PAC'07  
 (can be found on our Web Page <http://ilc-mdi.lal.in2p3.fr/spip.php?article54>)

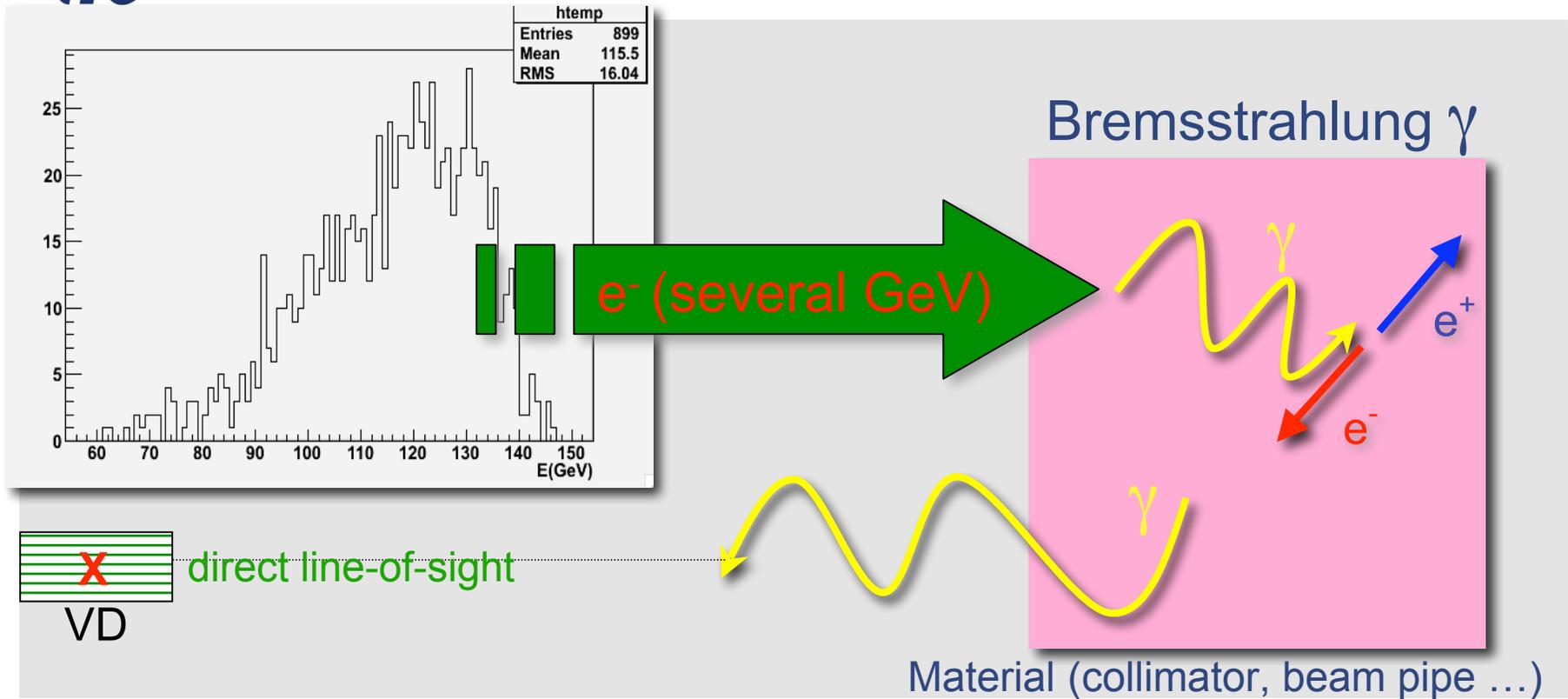


## 2mrad disrupted beam losses (QEX1COLL)

200 W power loss @ 45m on a Cu collimator (X=20cm)



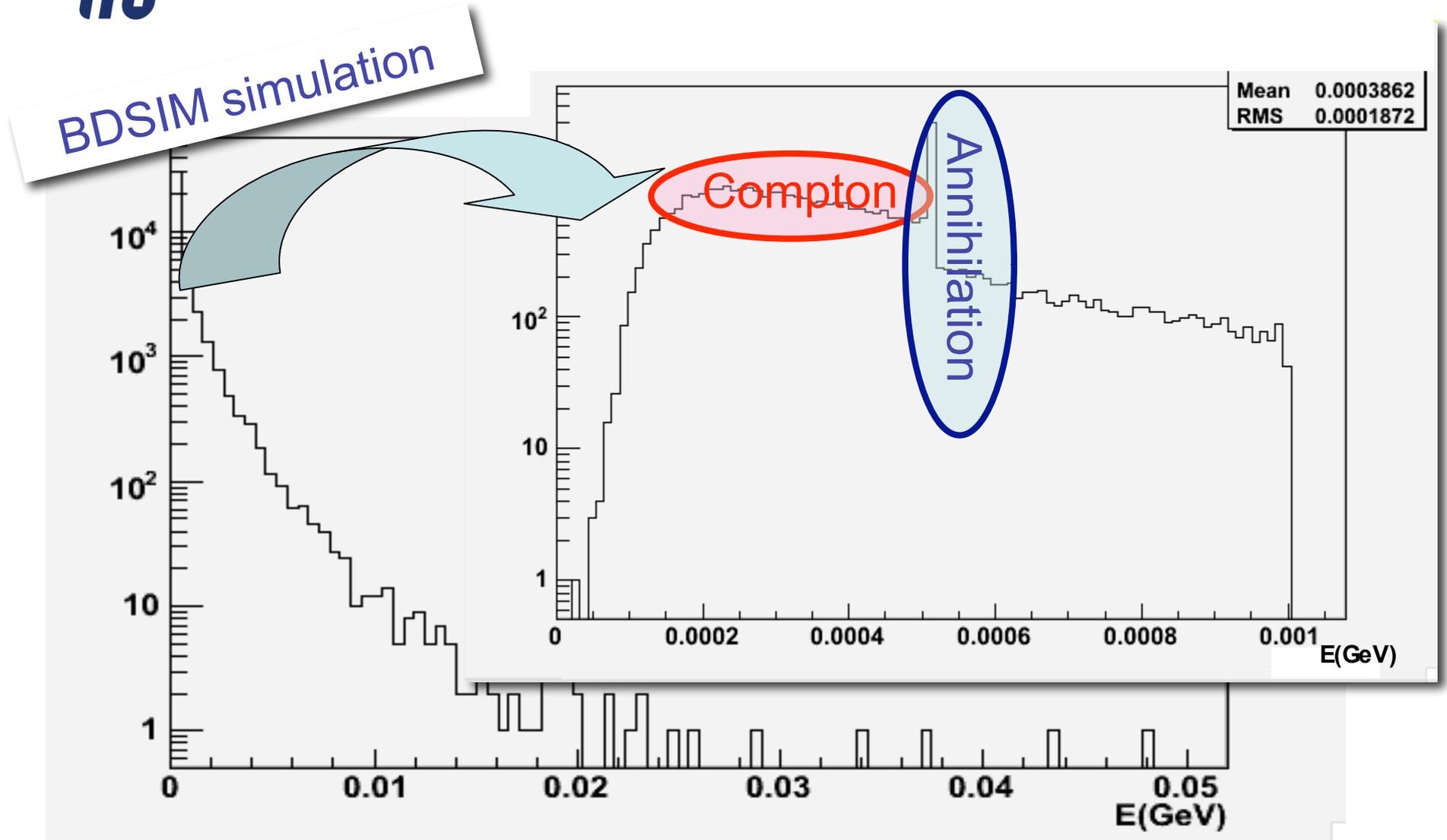
# Main processes for backscattered $\gamma$



Backscattered  $\gamma$  from cascades of processes:

- Bremsstrahlung
- Compton
- if  $e^+$ , annihilation
- Xray emission (can not be seen here due to our energy threshold)

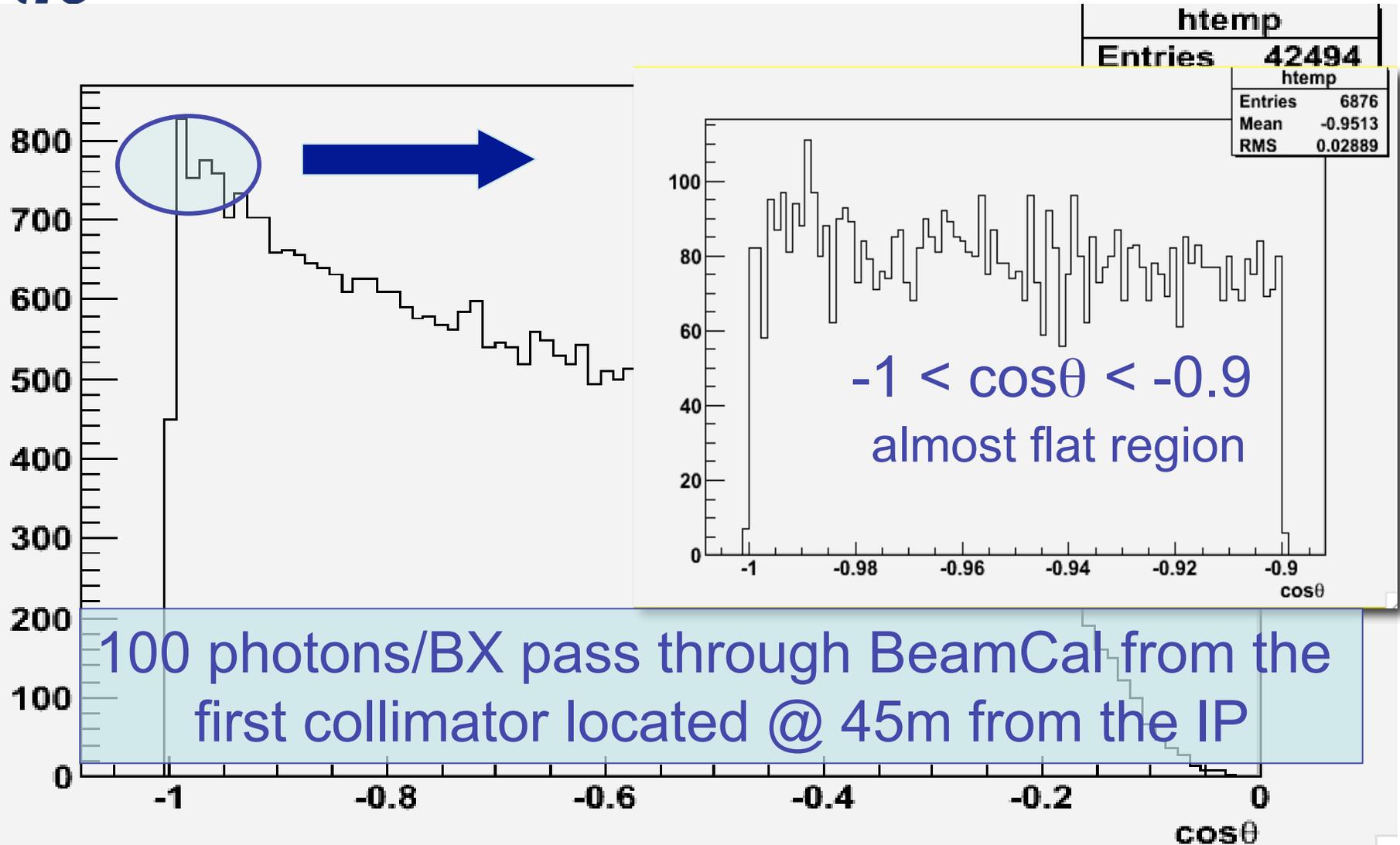
# Backscattered $\gamma$ spectrum



How many  $\gamma$  can pass through the BeamCal  $r=12$  mm with  $\theta \sim 12\text{mm}/45\text{m}$  ?



# Extrapolation using flatness of $\cos\theta$ distribution



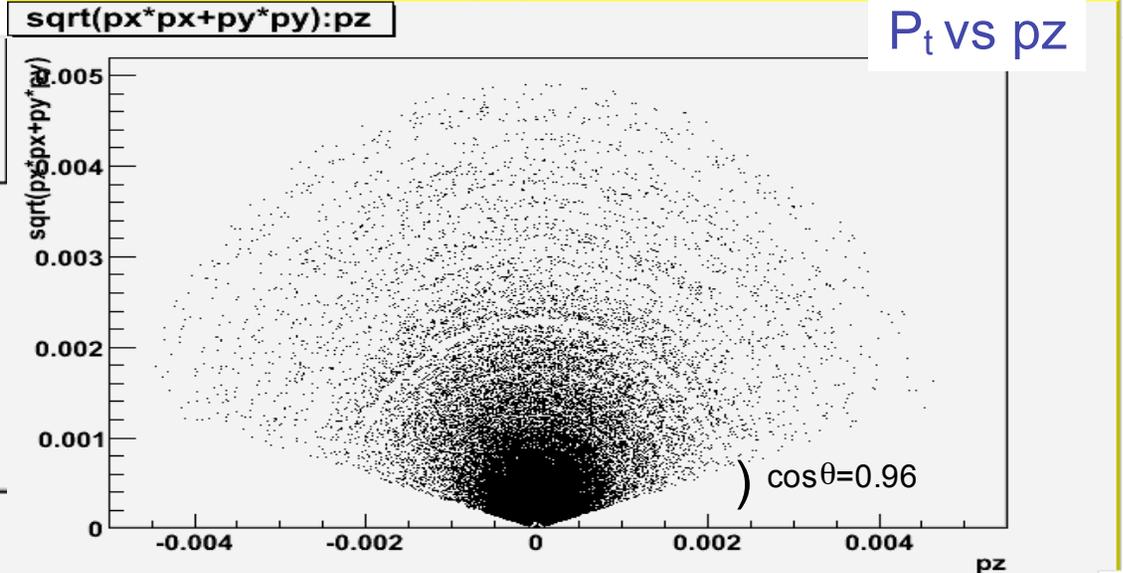
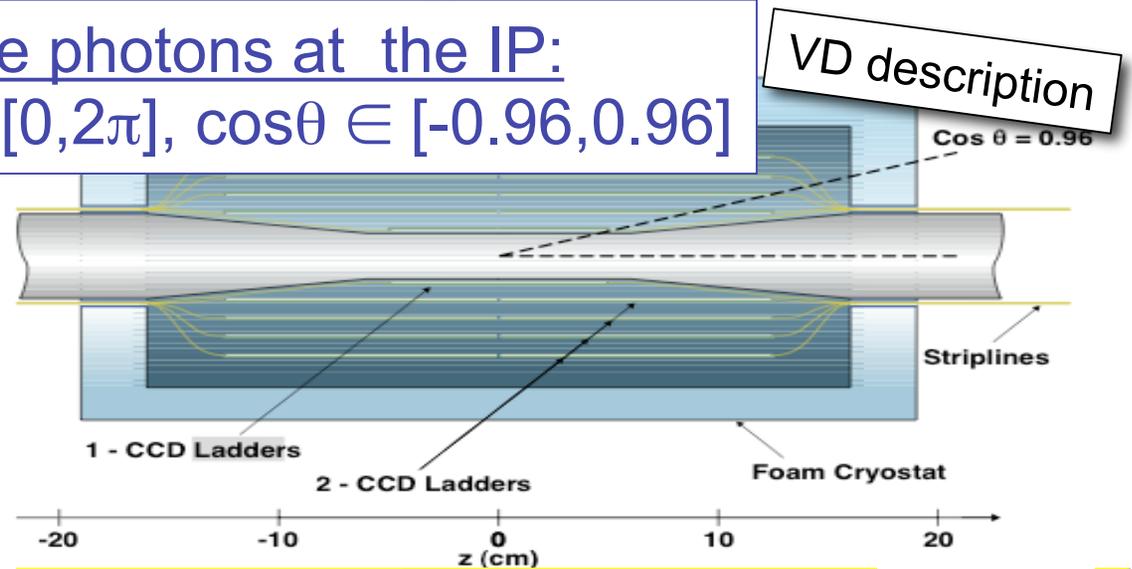
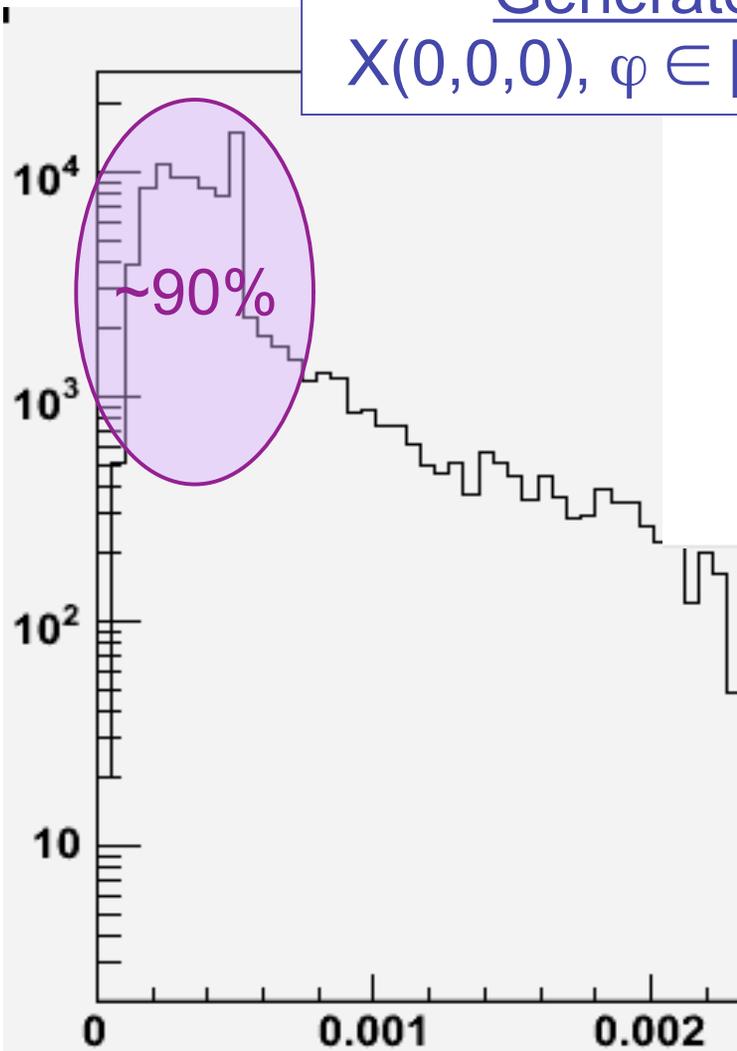
How many hits they will produce in the VD ?

# Mokka Simulation & Marlin reco.(1)

$\gamma$  generated at the IP

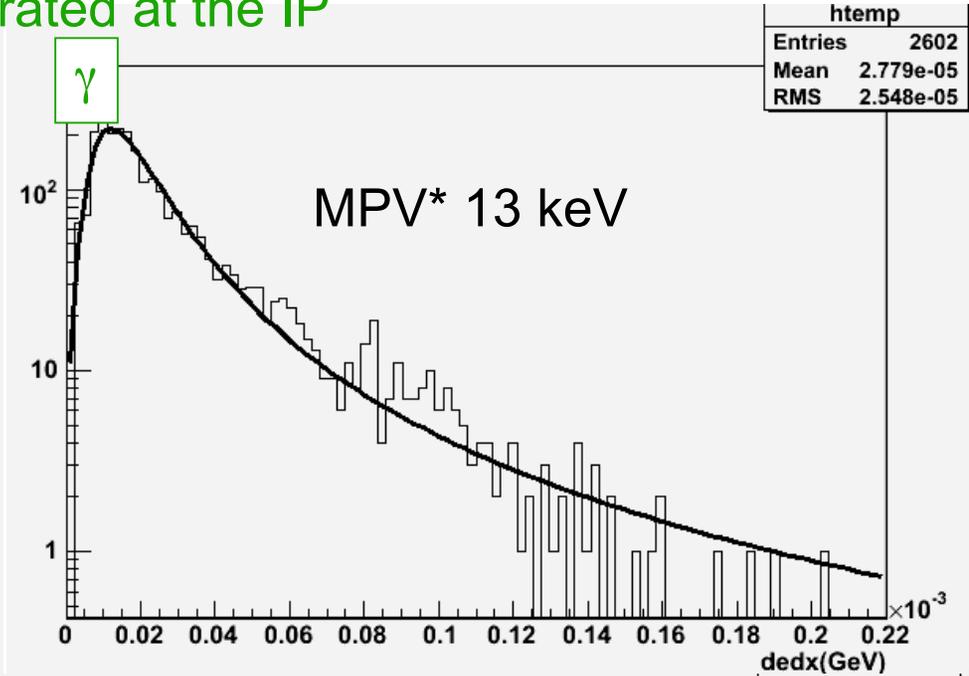
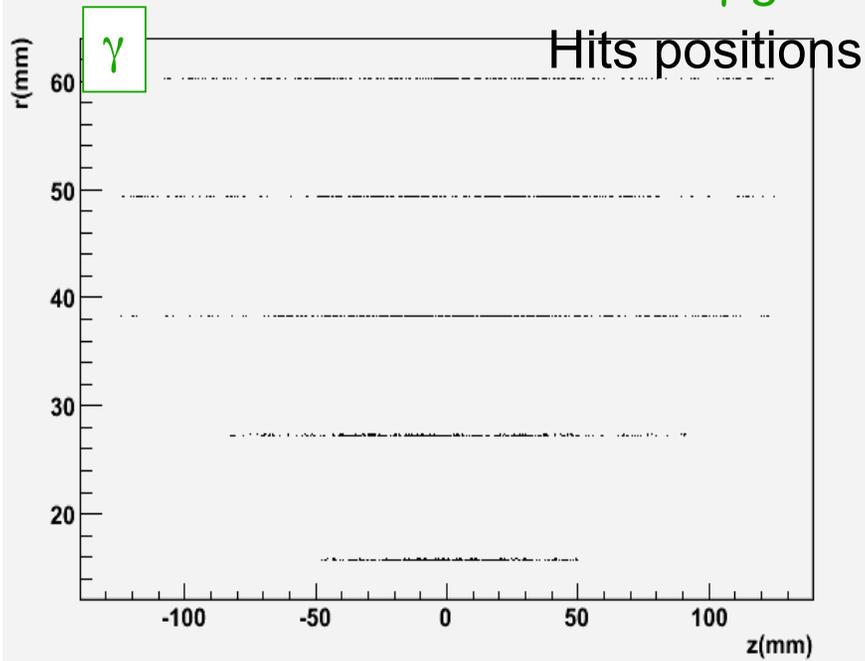
To see the detector response with those low energy  $\gamma$  need to study a simple case

Generate photons at the IP:  
 $X(0,0,0)$ ,  $\varphi \in [0,2\pi]$ ,  $\cos\theta \in [-0.96,0.96]$



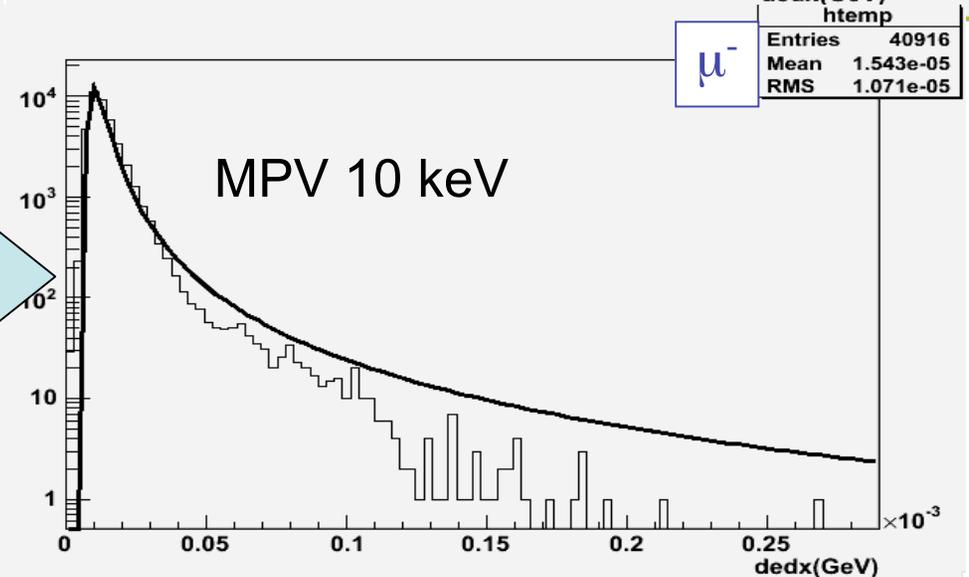
# Mokka Simulation & Marlin reco.(1)

$\gamma$  generated at the IP



To calibrate we use:  
10 GeV  $\mu^-$  same spatial dist.

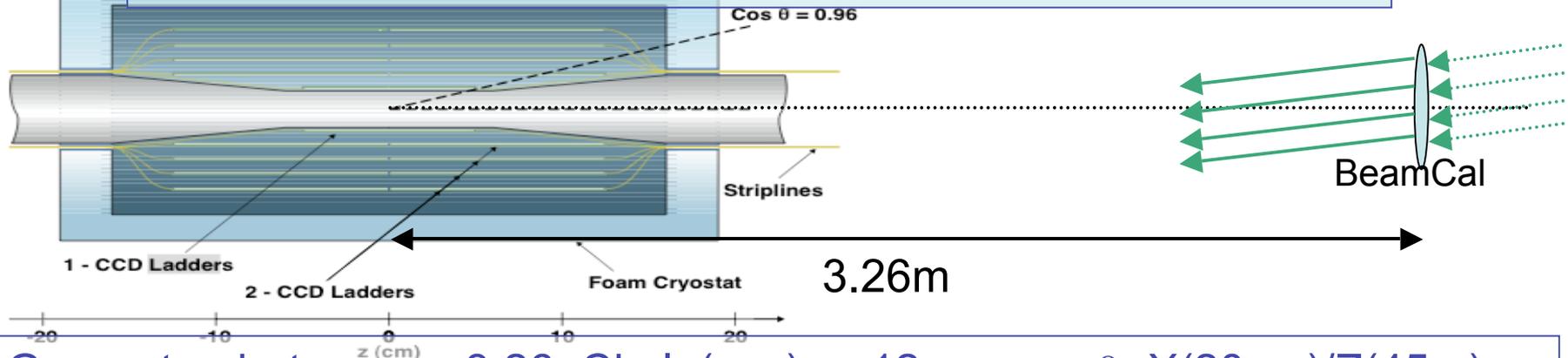
- Active Si 37  $\mu\text{m}$
- $\rho=2.33 \text{ g/cm}^3$
- $(dE/dx)_{\text{min}}=1.664 \text{ MeV}/(\text{g/cm}^2)$   
(for Si  $E_{\text{MPV}} \sim 0.7 * E_{\text{mean}}$ )



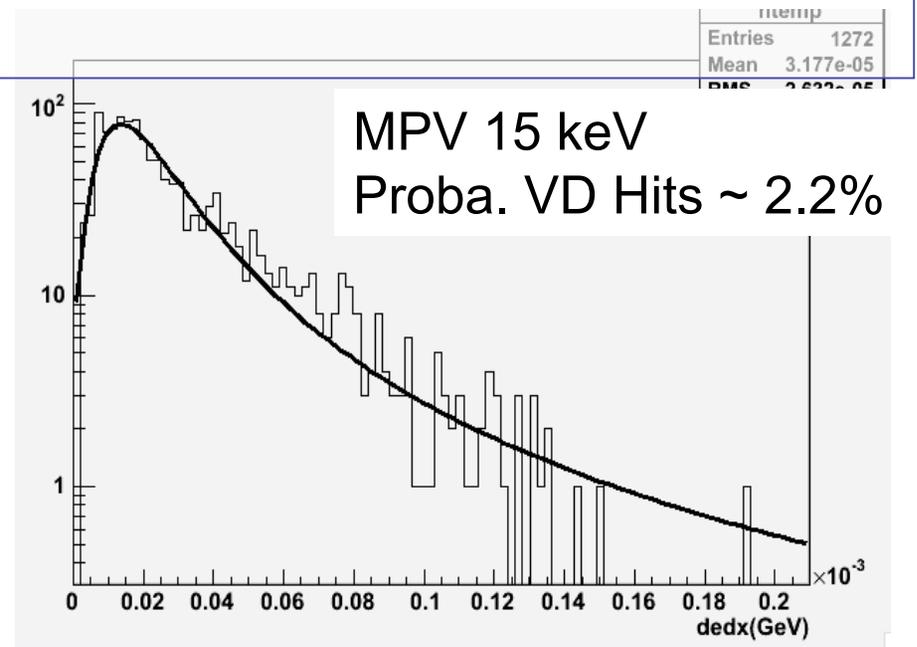
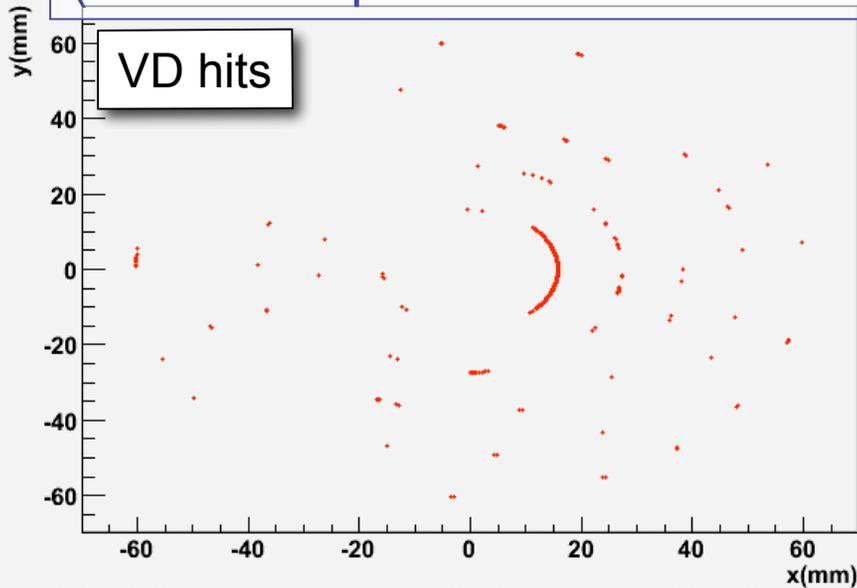
# Mokka Simulation & Marlin reco.(2)

$\gamma$  generated with very small angle

Study the direct lines of sight passing through the BeamCal



Generate photons:  $z=3.26$ , Circle( $x, y$ ),  $r=12\text{mm}$ ,  $\cos\theta=X(20\text{cm})/Z(45\text{m})$   
 (Beam loss position at QEX1COLL)



left-right asymmetry, emission point offset in one side



## VD Hits in the minimal 2mrad (nominal)

Assuming the same energy spectrum for the beam particles lost on collimators, the fraction of VD hits from other backscattered  $\gamma$  emission sources will be the same:  $\sim 2.2\%$

	D[m]	X[cm]	P[kW]	# $\gamma$ s/BX	VD hits/BX
QEX1COLL	45	20	0.2	1.3	0.02
QE2COLL	53	-	0	0	0
BHEX1COLL	76	41	0.1	0.2	0.004
COLL1	131	85	52.3	40	0.8
COLL2	183	115	207.5	82	1.8
COLL3	286	-	0	0	0

Even for high luminosity parameters hits are negligible



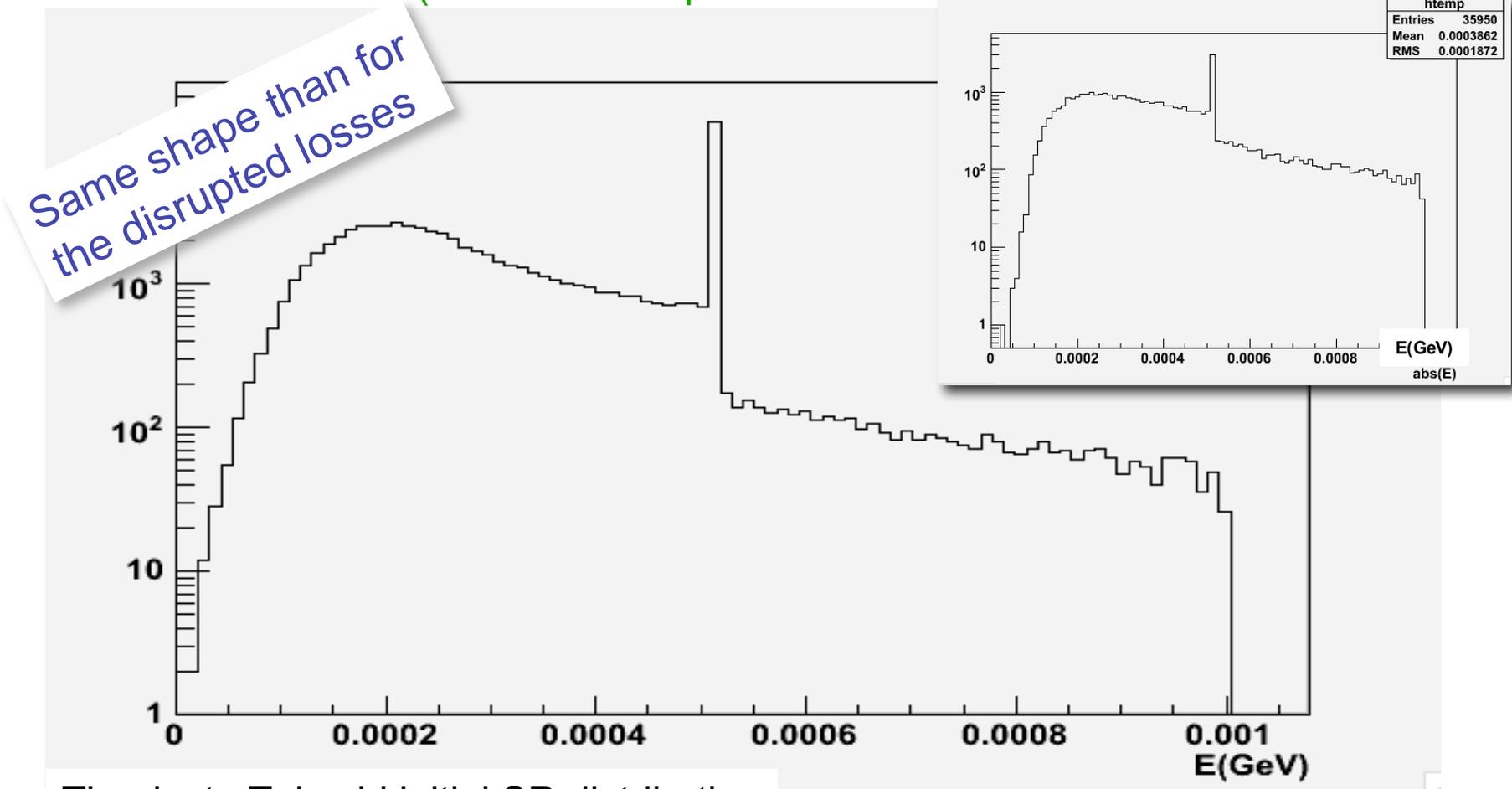
## Conclusion & prospects

- Back-scattered photons due to disrupted beam losses in the 2mrad produce negligible effects in the VD
- Further studies planned include a more complete analysis of all photon emission sources (synchrotron radiation from QD0 for example)
- Further studies planned include other backscattered particles (neutron)
- Study the other IR geometries under consideration including backscattering from the main beam dump and taking into account multiple reflections on the beam pipe



# Backup slides

Backscattered  $\gamma$  energy from QD0 SR  
(Cu for the septum material @ 90 m)



Same shape than for the disrupted losses

Thanks to Takashi initial SR distribution

2200  $\gamma$ /BX at the IP \* 2.2% ~ 50 VD hits/BX < 300 direct hits from incoherent pairs  
(Cecile Rimbault's et al. paper)